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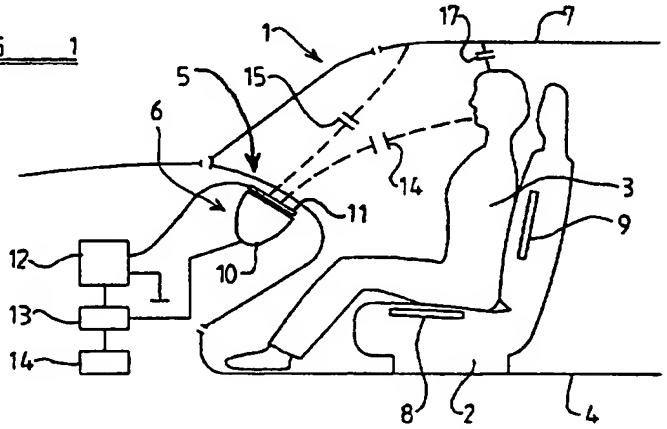
(54) Airbag arrangement sensing proximity of a vehicle occupant

(57) An airbag arrangement is provided with capacitive proximity sensing means adapted to sense the position of an occupant 3 of a vehicle 1 and provide a signal to a control means 13 to affect the deployment of the airbag 6 depending on that position. The sensing means may comprise at least one conductive electrode 11 located on or adjacent the front dashboard 5 or steering wheel and forming part of a capacitor, the capacitance of which is measured to provide said signal. The airbag deployment may be inhibited or modified when the measured capacitance or rate of change of capacitance exceeds a threshold. There may be two metal foil electrodes on or around an airbag housing door on the dashboard. The means of modifying the airbag deployment may be a pyrotechnic piston and cylinder which forms an opening in an airbag (figure 6). Alternatively the airbag may not deploy with a child safety seat in the vehicle (figure 3).

FIG 1



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

FIG 1

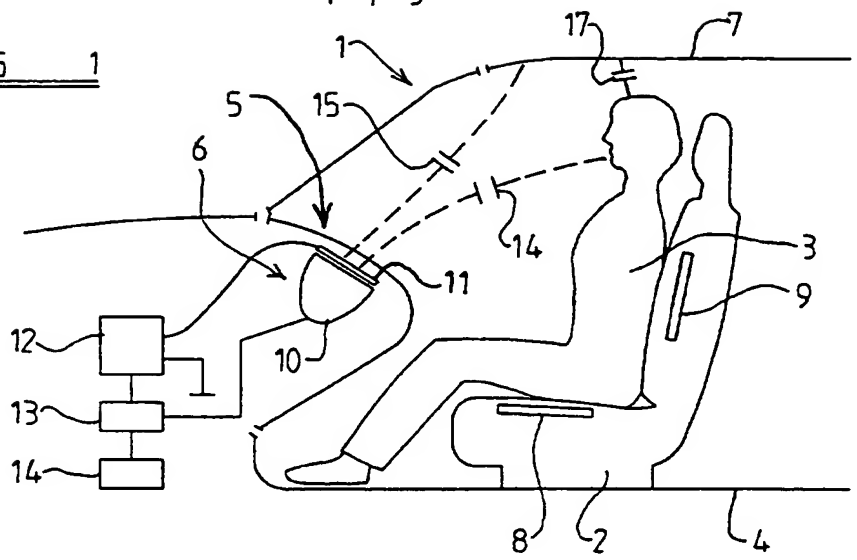


FIG 2

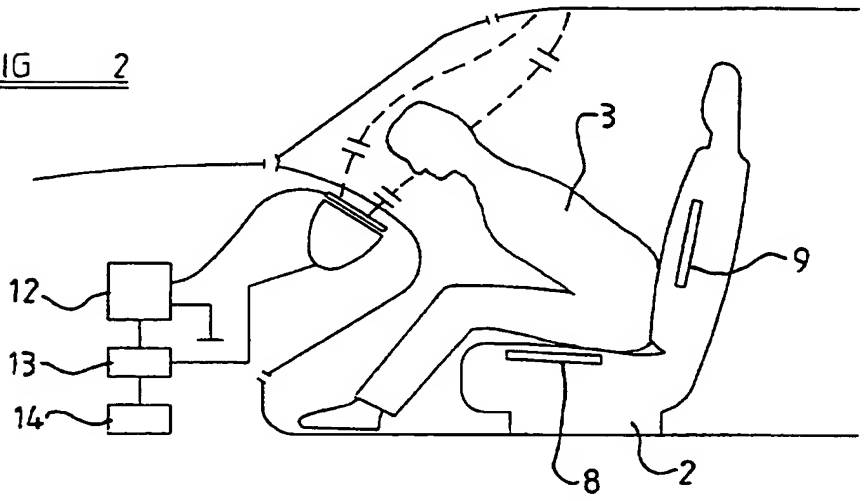


FIG 3

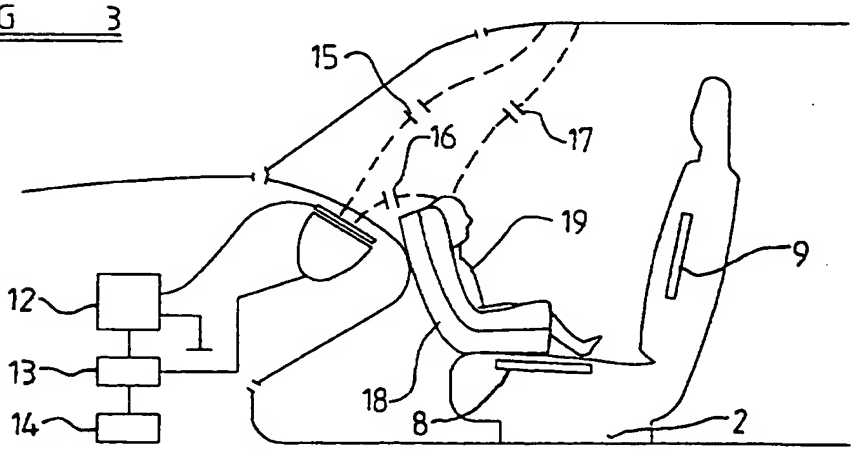


FIG 4

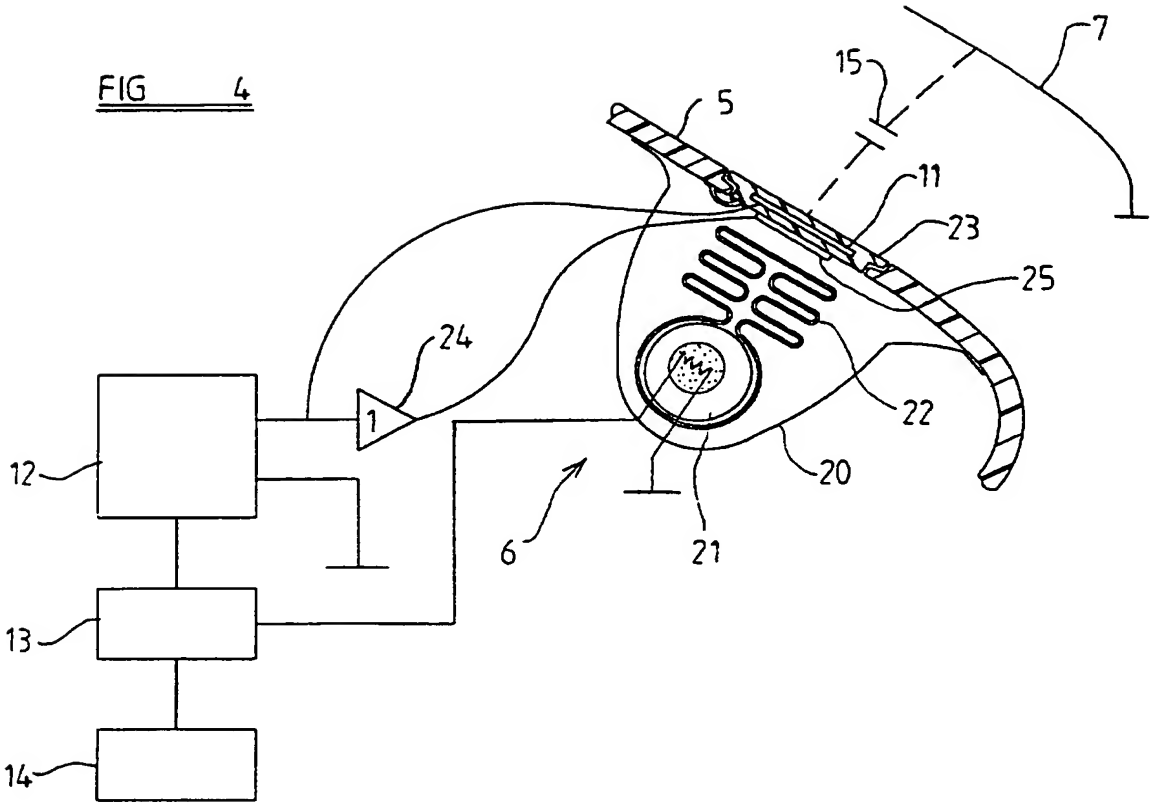
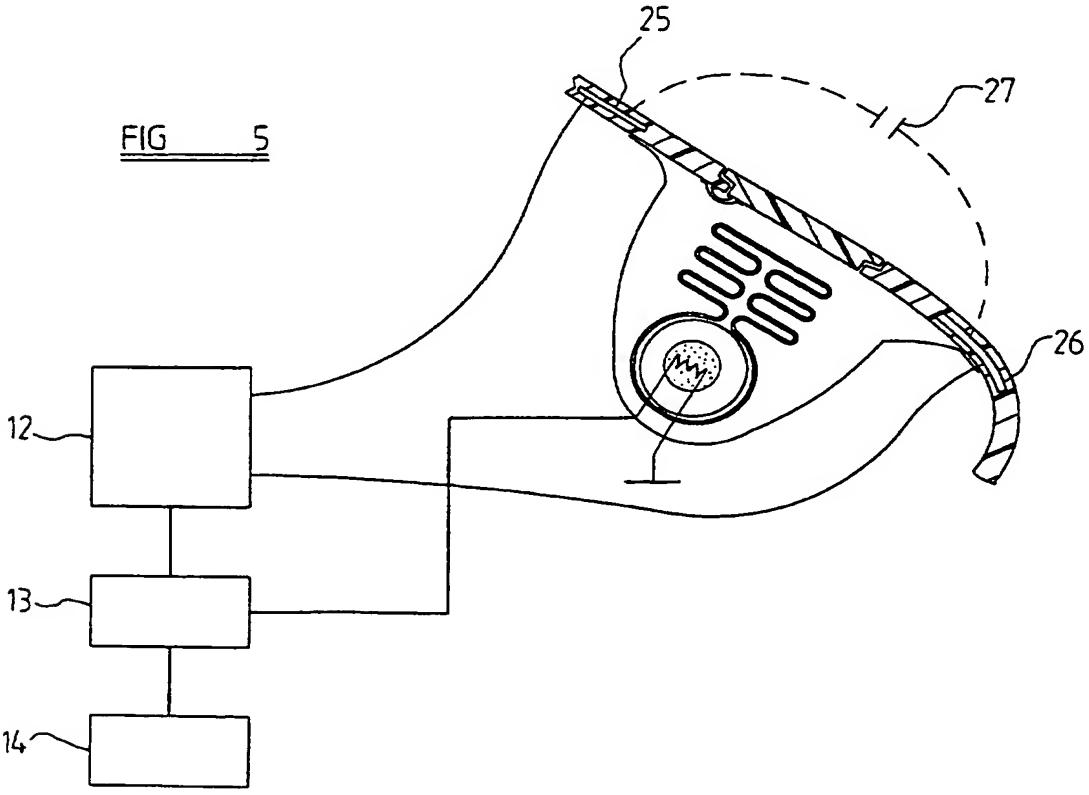


FIG 5



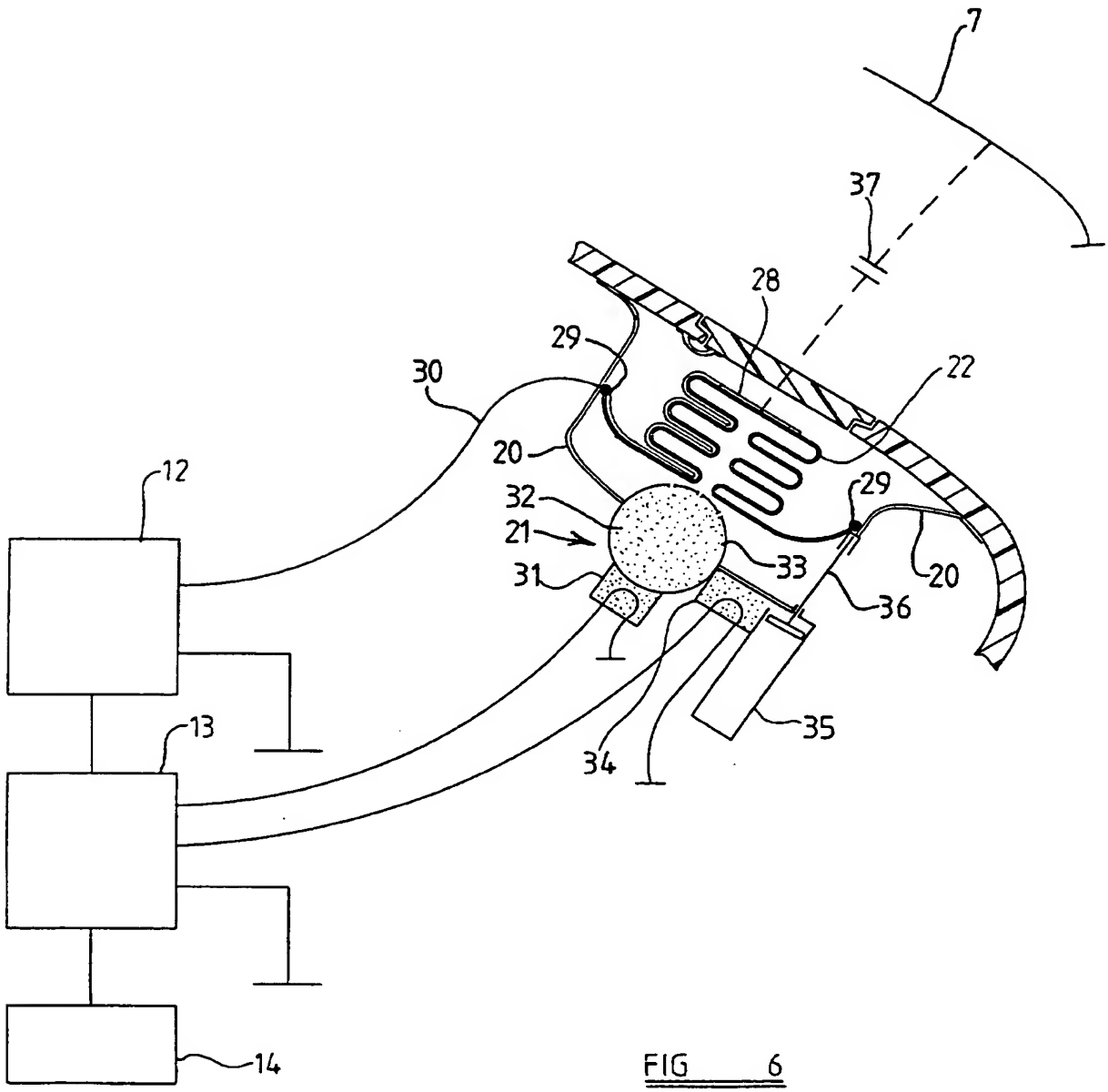


FIG 6

DESCRIPTION OF INVENTION

"IMPROVEMENTS IN OR RELATING TO AN AIR-BAG ARRANGEMENT"

THE PRESENT INVENTION relates to air-bag arrangement, and more particularly relates to an air-bag arrangement which incorporates a proximity detector adapted to detect a passenger or other occupant of a motor vehicle.

It has been proposed to provide a motor vehicle, such as a motor car, with an air-bag which is mounted in the steering wheel or in the dashboard located immediately in front of the driver or the front passenger seat of the motor vehicle. The air-bag is adapted to inflate in the event that an accident should arise, and thus provides an inflated element which tends to retard any forward movement of the head and torso of the driver or the front seat passenger of the motor vehicle.

Such an air-bag, if it is to perform its function correctly, must be inflated very rapidly, typically in less than 40 ms. If the driver or the passenger is sitting in a forwardly inclined position, with their head located near the steering wheel or dashboard of the motor vehicle at the instant that inflation of the bag commences, the air-bag, as it inflates, may impact of the head of the occupant of the vehicle and may effect injury to the occupant of the vehicle.

If a rear-facing child safety-seat is provided, which is mounted on the front passenger seat of the

vehicle, with the back part of the child safety-seat located adjacent the dashboard, should the air-bag be inflated, the inflating air-bag can impact violently with the safety-seat and may impart a substantial acceleration to the safety-seat. In certain circumstances, a young child initially contained in such a safety-seat can be ejected from the motor vehicle through the rear window.

It has been proposed previously to provide a proximity sensor in a motor vehicle adapted to provide an output when the driver or occupant of the front passenger seat is located close to the dashboard. For example, it has been proposed to use infra-red or ultra-sonic rays passing close above the dashboard, from a transmitter on one side of the motor vehicle to a receiver on the other side of the motor vehicle. When the infra-red or ultra-sonic rays are interrupted, a signal is generated indicating that the driver or the occupant of the front passenger seat of the vehicle is leaning forwardly, which may be used to inhibit employment of the air-bag. Other prior proposals include means which measure the distance of the object which is closest to the dashboard. It has also been proposed to utilise a video camera and to analyse images from the video camera to determine the position of the occupant of the vehicle.

The infra-red and ultra-sonic sensors that have been proposed previously are relatively heavy. The video camera is relatively expensive. Many of these sensors are also quite capable of providing a "false" output, especially if the passenger of the vehicle is holding a relatively solid object in their hands, or an opaque object, such as, for example, a map or book.

The present invention seeks to provide an air-bag arrangement that incorporates a proximity sensor that may be utilised in a motor vehicle and which is adapted to respond to inhibit or modify deployment of the air-bag when the driver or an occupant of the vehicle is located relatively close to the proximity sensor.

According to this invention there is provided an air-bag arrangement in a motor vehicle, the air-bag arrangement comprising an air-bag and an associated gas generator and means adapted to initiate inflation of the air-bag in the event that an accident should arise, the air-bag being located in such a position that, when inflated, it is situated in front of a front seat occupant of a motor vehicle, the vehicle being provided with proximity sensing means adapted to sense when the occupant within the vehicle is located at least partly adjacent the position that will be occupied by the air-bag when it is inflated in front of the front dashboard or steering wheel of the vehicle, the proximity sensing means comprising at least one conductive electrode, said electrode being located on or adjacent the front dashboard or steering wheel of the motor vehicle, said electrode forming part of a capacitor, capacitance measuring means being provided to generate a signal representative of or related to the capacitance of said capacitor and control means being provided to inhibit or modify deployment of the air-bag when said signal exceeds predetermined parameters.

Preferably the control means are adapted to inhibit or modify deployment of the air-bag when the measured capacitance of the capacitor exceeds a predetermined threshold.

Conveniently the control means are adapted to inhibit or modify deployment of the air-bag when the rate of change of capacitance of the capacitor exceeds a predetermined threshold.

Preferably said capacitance is defined between one or more said electrodes located on or adjacent the dashboard and the body of the motor vehicle.

Advantageously the capacitance is defined between two said electrodes located on or adjacent the dashboard of the vehicle.

Conveniently the air-bag is provided with an housing, the housing being provided with a door through which the air-bag may emerge when inflated, the door forming part of the dashboard of the vehicle, said electrode being mounted on, or adjacent said door.

Preferably said electrode is moulded integrally with the door.

Advantageously the door is provided with a second electrode which is connected to the first electrode by means of a buffer amplifier having a high impedance, so as to provide a shielding effect for the first electrode from all items mounted on the side of the second electrode remote from the first electrode.

Conveniently the or each electrode is a metal foil.

Advantageously two electrodes are provided in the dashboard or steering wheel, the capacitance measuring means being adapted to measure the capacitance between said two electrodes.

Preferably the electrode or electrodes are provided in the dashboard or steering wheel adjacent the periphery of the door.

Conveniently two electrodes are provided on opposed sides of the door.

Advantageously the electrode comprises a frame surrounding the periphery of the door.

Conveniently the electrode is provided on the outer surface of the air-bag at such a position that, when the air-bag is in the folded state, the electrode lies immediately adjacent the dashboard.

Preferably the capacitance measuring means discharge the charge on the capacitor through a known resistance and determine the time taken for the charge to fall by a predetermined amount.

Conveniently the capacitance measuring means comprise an oscillating circuit, the capacitance forming part of the oscillating circuit, means being provided to determine the frequency of oscillation of the oscillating circuit.

Advantageously means are provided to modify the deployment of the air-bag comprising means adapted to establish an opening communicating with the interim of the air-bag.

Preferably the means to establish an opening communicating with the interior of the air-bag comprise a piston and cylinder arrangement, a pyrotechnic charge associated with the piston and cylinder arrangement

adapted, when activated, to cause the piston to move within the cylinder, means connecting the piston to part of the combination of the air-bag and the housing, the arrangement being such that when the pyrotechnic charge is activated, the piston moves, thus separating said part from the rest of the combination air-bag to cause the opening to be established.

Conveniently the or each electrode is located so that the front surface of the dashboard lies substantially on a notional equi-potential surface of the resulting capacitor.

Advantageously at least one sensor is provided in said front seat, responsive to an occupant of the seat, the sensor providing a signal to said control means.

Preferably the sensor is in the squab of the seat.

Conveniently the sensor is in the back of the seat.

Preferably the seat is provided with at least one capacitive sensor.

Advantageously deployment of the air-bag is inhibited when said passenger is closer than a predetermined distance from said dashboard.

Preferably said distance is in the range 150-200 mm.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described, by way of

example, with reference to the accompanying drawings in which:

FIGURE 1 is a diagrammatic view of part of a motor vehicle in the form of a motor car, provided with an air-bag arrangement which incorporates a proximity sensor in accordance with the invention, showing the occupant of the vehicle in an initial position,

FIGURE 2 is a view corresponding to Figure 1 showing the occupant of the vehicle in an alternative position,

FIGURE 3 is a view of a vehicle corresponding with the vehicle in Figure 1, illustrating a child safety-seat in position on the front seat of the vehicle,

FIGURE 4 is an enlarged, partly diagrammatic sectional view, through the dashboard of the vehicle of Figure 1,

FIGURE 5 is a view corresponding to Figure 4 illustrating an alternative embodiment of the invention, and

FIGURE 6 is a view corresponding to Figures 4 and 5 illustrating a further embodiment of the invention.

Throughout the Figures like references refer to like parts.

Referring initially to Figure 1, a motor vehicle 1 is provided which has a front passenger seat 2 which is illustrated as being occupied by a passenger 3.

The seat 2 is supported on a metal floor 4 which forms part of the chassis of the vehicle. The chassis of the vehicle also defines a dashboard 5 which accommodates an air-bag arrangement 6 which we describe in greater detail hereinafter. The chassis of the vehicle forms part of a monocoque shell which incorporates a metal roof 7.

The seat 2 incorporates a sensor provided in the squab of the seat, such as a sensor 8 adapted to detect the presence of an occupant 3 of the seat. The sensor 8 may comprise a pietzo-resistive element.

The seat 2 incorporates a second sensor 9 in the back part of the seat. The second sensor 9 may comprise a capacitative element, the capacitance of the capacitative element changing, depending upon the position of the torso of the occupant 3 of the motor vehicle relative to the back of the seat.

The air-bag arrangement 6 provided in the dashboard 5 comprises a housing 10 which contains an air-bag and a gas generator, adapted to supply gas to the air-bag. A metal foil forming capacitative electrode 11 is provided which is mounted adjacent the upper part of the housing for the air-bag, just beneath the upper surface of the dashboard. The electrode 11 is connected to a capacitance measuring device 12. The capacitance measuring device 12 is connected to a control signal generator 13. The control signal generator 13, in turn, is connected to the gas generator within the housing 10 containing the air-bag arrangement 6 so as to control the mode of operation of the air-bag. A crash sensor 14 is connected to the control signal generator.

The metal electrode 11 that is provided beneath the dashboard forms one electrode of a notional capacitor. The other electrode comprises the body of the motor vehicle. When the motor vehicle is empty, the other electrode of the capacitor comprises solely the monocoque shell of the motor vehicle, and in particular, the roof 7. Typically, the capacitance 15 of the capacitor that comprises the electrode 11 and the monocoque shell of a motor vehicle may be relatively low, of the order of 20 pF.

If an occupant is present within the vehicle, such as the occupant 3 illustrated in Figure 1, if the occupant is sitting in the upright position, as illustrated in Figure 1, there will be an alteration in the situation. There may well be a capacitative link 16 between the electrode 11 and the passenger of the motor vehicle 3 of about 5 pF, and also a further capacitative link 17 between the occupant 3 of the vehicle and the monocoque shell of approximately 150 pF.

The total capacitance thus detected at the electrode 11 comprises 20 + 1/(1/5 + 1/150) = 25 pF.

Should the occupant of the vehicle be leaning forwardly, as shown in Figure 2, the situation will change. The capacitance 15 between the metal electrode 11 and the monocoque shell will still be 20 pF, but the capacitative link 16 between the occupant of the vehicle and the metal electrode 11 will be much higher, typically 50 pF, because the head of the occupant is now much closer to the metal electrode 11. The capacitative link 17 between the head of the occupant of the monocoque shell will still be approximately 150 pF. In this situation, the total capacitance detected at the electrode 11 may be 20 + 1/(1/50 + 1/50_ = 57 pF.

The capacitance measuring device 12 is adapted to provide an output to the control signal generator 13 whenever the measured capacitance exceeds a predetermined threshold. In the example given, the threshold may be, say, 40 pF. This may equate to the occupant 3 of the motor vehicle being spaced from the dashboard 5 by a distance of 150-200 mm.

Alternatively the capacitance measuring device is adapted to provide an output to the control signal generator when the measured capacitance of the capacitor changes by more than a predetermined amount, or changes at a rate greater than a predetermined rate.

When no signal is received from the capacitance measuring device, but signals are received from the sensor 8 provided in the squab of the seat, and the sensor 9 provided in the back of the seat, the air-bag may be activated when an accident is sensed by the crash sensor 14. However, in a situation where the control signal generator 13 receives a signal from the sensor 8, which indicates that there is an occupant 3 sitting on the seat, but no signal from sensor 9, meaning that the torso of the occupant is not adjacent the back of the seat, and equally no signal from the capacitance measuring device 12, then the air-bag may be activated, but may only be half inflated, or may have its operational characteristic altered in some other way, since with this combination of signals the occupant of the seat may be leaning forward slightly.

However, if the capacitance measuring device 12 measures a capacitance greater than a predetermined threshold, then, even if an accident should arise, the air-bag will not be triggered, since the situation may well be

that the head of the occupant is located immediately adjacent the housing 10 for the air-bag, and if the air-bag were to be inflated with the occupant of the vehicle in this position, severe damage might be effected to the occupant of the vehicle.

Turning now to Figure 3, it can be seen that when a child safety-seat 18 is provided in the motor vehicle, and a child 19 is present in the seat, the capacitance experienced by the electrode 11 with the monocoque body of the motor vehicle will be approximately 20 pF, but the capacitance 16 between that plate and the head or body of the child 19 occupying the safety-seat will be approximately 30 pF, and the capacitance 17 between the child 19 in the safety-seat and the monocoque shell will be approximately 100 pF. Thus the total capacitance experienced at the electrode 11 will be $20 + 1/(1/30 + 1/100) = 43$ pF. This capacitance exceeds the predetermined threshold of 40 pF mentioned above, and consequently even if an accident should arise, the air-bag present in the housing 10 will not be deployed.

Turning now to Figure 4 it can be seen that the air-bag arrangement 6 comprises a housing 20 which is associated with a gas generator 21 which, in turn, is associated with an air-bag 22. The air-bag 22 is initially in a folded condition and is retained within the housing 20. The housing 20 is closed by a door 23 which is adapted to open in the event that the air-bag is inflated to permit the inflated air-bag to be located in front of the passenger 3 of the motor vehicle. The door 23 forms an integral part of the dashboard 5 of the motor vehicle.

A metal electrode 11, which is constituted by a metal foil, is moulded within the door 23 which may be

formed of a plastics material. The electrode 11 is connected to the capacitance measuring device 12. However, the electrode 11 is also connected by means of a high impedance to a further electrode 25, comprising a further metal foil which is located on the inner surface of the door 23. The electrode 25 acts as a shielding electrode. The electrode 25 is maintained at substantially the same potential as the electrode 11, but is not subjected to rapid fluctuations in response to changes in potential on the electrode 11, due to the presence of the high impedance 24. The notional capacitance 15 and the roof 7 are illustrated.

Figure 5 illustrates a modified embodiment of the invention, where the single electrode 11 is replaced by two electrodes 25,26 which are mounted in the dashboard on either side of the door 23. The capacitance 27 between the respective electrodes 25 and 26 may be measured by the capacitance measuring device 12. The capacitance 27 will alter if the occupant of the vehicle approaches the dashboard.

Alternatively, the electrodes 25,26 may form part of an integral metallic frame totally surrounding the opening of the door 23, in which case the capacitance between this single composite electrode and the monocoque body would be measured, in a manner similar to that described above.

While the invention has been described with reference to embodiments in which metal electrodes are mounted on the dashboard in front of a front seat passenger to determine the position of a front seat passenger, in alternative embodiments the electrodes may be mounted on

the steering wheel and/or the dashboard in front of the driver to determine the position of the driver.

Figure 6 illustrates a further modified embodiment of the invention. In this embodiment of the invention, an electrode 28 is provided which is mounted on the outer part of the air-bag 22 contained within the housing 20. In this embodiment the housing 20 comprises either part of the dashboard or part of the steering wheel. The air-bag 22 has an open mouth which is fixed by an appropriate bead or seal to the housing 20.

The capacitance measuring device 12 is connected to the electrode 28 by a connecting wire 30 which enters the housing 20 and which is loosely secured to the exterior of the folded air-bag 22, and which extends to the electrode 28.

The gas generator 21 comprises a pyrotechnic charge 31 adapted to activate the gas generator and a propellant charge 32 which is adapted to be ignited to generate gas to inflate the air-bag. The gas generator is adapted to supply gas to the interim of the housing 20. The combination of the housing 20 and the air-bag 22 forms a single enclosure and thus the air-bag is inflated. The charge 32 is contained in a cylinder 33 that is formed integrally with the housing 20.

A further pyrotechnic charge 34 is provided adapted to supply gas to a piston and cylinder arrangement 35 that forms an integral part of the housing 20 to drive the piston along the cylinder. The piston is connected to a venting valve 36 adapted to establish an opening within the wall of the housing 20. Thus, an opening is created communicating with the interior of the air-bag. As the

piston moves the integrity of the housing 20 is broken so that gas within the combination of the housing and the air-bag can escape to the atmosphere.

The capacitance measuring circuit 12 is adapted to measure to the total capacitance 34 between the electrode 28 provided on the air-bag 22 and the monocoque shell of the motor vehicle, in particular the roof 7 of the motor vehicle.

The output of the capacitance measuring circuit 12 is provided to the control signal generating circuit 13 which, in response to a signal from the crash detector 14, provided that the signal from the capacitance measuring circuit 12 is appropriate, generates a signal which ignites the pyrotechnic charge 29 for the gas generator. The propellant 32 is thus ignited and creates gas to inflate the air-bag. The gas enters the sealed housing 20 and inflates the bag 22.

However, if certain criteria are met, that is to say if the capacitance measured by the capacitance measuring circuit exceeds a certain threshold, the control signal generator 13 generates a further control signal which ignites the pyrotechnic charge 34. This causes the piston to move along the piston and cylinder arrangement 32. As the piston moves the part 33 of the air-bag is separated from the rest of the air-bag thus establishing an opening within the air-bag 22. Also the integrity of the housing 20 is broken to permit gas in the air-bag to escape to the atmosphere. Thus the air-bag 22 is not fully inflated when the pyrotechnic charge 34 is activated.